JAPANESE PATENT OFFICE
PATENT JOURNAL (A)
KOKAI PATENT APPLICATION NO. HEI 9[1997]-55770

Int. Cl.^{6}:	H 04 L 25/49 H 03 K 5/125 H 04 L 25/03 H 03 K 5/01
Filing No.:	Hei 7[1995]-209567
Filing Date:	August 17, 1995
Publication Date:	February 25, 1997
No. of Claims:	8 (Total of 7 pages; OL)
Examination Request:	Filed

DEVICE FOR TRANSMITTING PREDETERMINED FREQUENCY RESPONSE OUTPUT VIA UNSHIELDED TWISTED-PAIR MEDIUM, WAVEFORM SHAPING CIRCUIT, AND METHOD THEREOF

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[There are no amendments to this patent.]

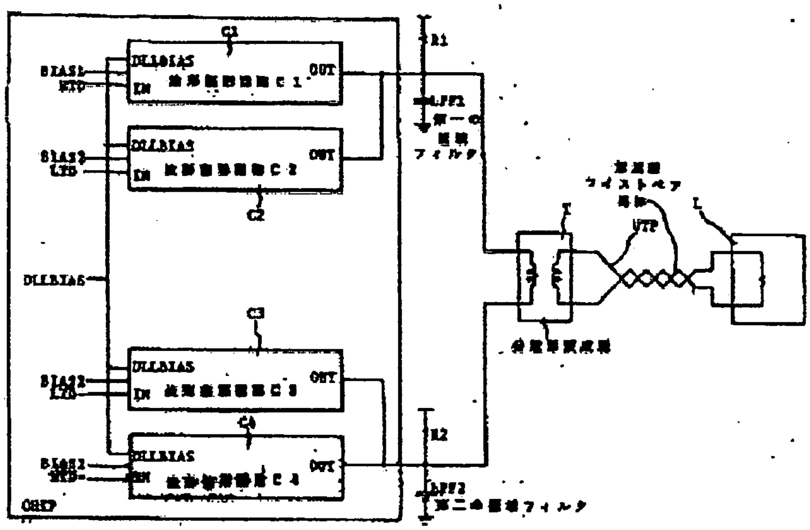
Abstract

Problem

To present a device for transmitting Manchester code data via an unshielded twisted-pair medium.

Solution

The waveform shaping circuit is equipped with an input terminal, an output terminal, and multiple cascade circuit stages; the aforementioned cascade circuit stages are each configured with a delay circuit equipped with an input part and an output part, a current source, and a switching circuit; the aforementioned switching circuit is controlled by the aforementioned delay circuit when it is connected to the output of the delay circuit electrically so as to connect the current source to the aforementioned output terminal; each of the aforementioned delay circuits has the same delay time while the total of said delay times is ½ the bit time of the basic data rate or a multiple of that ½ the bit time; and each current source has a current value obtained from a finite impulse response time sample determined by the filter transfer function of the waveform shaping circuit.



Key:
C1-C4 Waveform shaping circuit
LPF1 First low-pass filter
LPF2 Second low-pass filter
T Discrete transformer
UTP Unshielded twisted pair medium

Claims

1. A waveform shaping circuit characterized in that it is equipped with an input terminal, an output terminal, and multiple cascade circuit stages; the aforementioned cascade circuit stages are each configured with delay circuit 10 equipped with an input part and an output part, current source 11, and switching circuit 12; the aforementioned switching circuit 12 gets electrically connected to the output of delay circuit 10 and is controlled by the aforementioned delay circuit 10 so as to connect current source 11 to the output terminal; delay circuit 10 of first cascade circuit stage 1 is electrically connected to the aforementioned input terminal, and the other delay circuits 10 are electrically connected to the outputs of the respective adjoining delay circuits 10 preceding them in the aforementioned multiple cascade circuit stages; each of the aforementioned delay circuit 10 has the same delay time; and the aforementioned current sources each has a current value obtained from a finite impulse response time sample determined by the filter transfer function of the waveform shaping circuit.

2. The waveform shaping circuit described in Claim 1, characterized in that the aforementioned filter transfer function has a raised-cosine impulse response.

3. A Manchester code data waveform shaping method characterized in that it involves a step in which a finite impulse response time sample is obtained based on a filter transfer function;

a step in which multiple current sources 11 each equipped with switching circuit 12 whose current values are in direct proportion to the time sample are provided; and

a step in which in multiple delay circuits each having the same delay time while the total of said delay times is ½ the bit time of Manchester code data, the Manchester code data are received by the input part of the first delay circuit, input parts of the other delay circuits 10 are electrically connected to the output parts of adjoining delay circuits 10 preceding them, and output parts of respective delay circuits 10 are electrically connected to switching circuits 12 which control [the path from] current sources 11 to the output terminal.

4. The waveform shaping method described in Claim 3, characterized in that the aforementioned filter transfer function has a raised-cosine impulse response.

5. A device for transmitting Manchester code data via an unshielded twisted-pair medium characterized in that it comprises a first, a second, a third, and a fourth waveform shaping circuits (C1, C2, C3, and C4); the aforementioned waveform shaping circuits are each configured with an input terminal, an output terminal, and multiple cascade circuit stages; the aforementioned cascade circuit stages are each configured with delay circuit 10 equipped with an input and output, current source 11, and switching circuit 12; the aforementioned switching circuit 12 is electrically connected to the output part of delay circuit 10 and controlled by the aforementioned delay circuit 10 so as to connect the current source to the output terminal; delay circuit 10 of first cascade circuit 1 is electrically connected to the input terminal, and the input parts of the other delay circuits are connected to the respective output parts of the delay circuits connected ahead of them in the aforementioned multiple cascade circuit stages; each of the aforementioned delay circuits 10 has the same delay time while the total of said delay times is ½ the bit time of Manchester code data; each of the aforementioned current sources 11 has a current value obtained from a finite impulse response time sample determined by the filter transfer function of the waveform shaping circuit; and the device is further configured such that the aforementioned first waveform shaping circuit receives Manchester code data as its input, the aforementioned second waveform shaping circuit receives delayed Manchester code data as its input, and the output terminal of the aforementioned second waveform shaping circuit and the output terminal of the first waveform shaping circuit are connected to each other, the third waveform shaping circuit receives inverted Manchester code data as its input, the aforementioned fourth waveform shaping circuit receives delayed inverted Manchester code data as its input, and the output terminal of the aforementioned third waveform shaping circuit and

the output terminal of the aforementioned fourth waveform shaping circuit are connected to each other.

6. The device described in Claim 5, characterized in that the aforementioned filter transfer function has a raised-cosine impulse response.

7. The device described in Claim 5, characterized in that the output terminals of the first and the second waveform shaping circuits are electrically connected to a first low-pass filter, and the output terminals of the third and the fourth waveform shaping circuits are electrically connected to a second low-pass filter.

8. The device described in Claim 7, characterized in that in a discrete transformer with a primary coil and a secondary coil, the primary coil is connected to the first low-pass filter and the second low-pass filter by either end, the CT (center tap) of the aforementioned primary coil is connected to a positive power supply, and the output end of the aforementioned secondary coil is connected to an unshielded twisted-pair medium.

Detailed explanation of the invention

[0001]

Industrial application field

The present invention pertains to a device for transmitting a response with a predetermined frequency and an output with a predetermined waveform via a communication medium. More specifically, it pertains to a device for transmitting Manchester code data via an unshielded twisted-pair medium that utilizes waveform shaping circuits and a method which can be implemented economically at low power consumption.

[0002]

Prior art

US Patent No. 5,267,269 discloses a device for transmitting Manchester code data via an unshielded twisted-pair medium. Said known device is configured with a sequencer equipped with a mode selection output terminal and a step selection output terminal and used to receive non-zero return data; a memory which stores data on multiple predetermined waveforms; a multiplexer which is equipped with a first input terminal connected to the step selection output terminal, a second input terminal connected to the mode selection output terminal, an input bus connected to the aforementioned memory, and an output bus; a latch which is equipped with I/O terminals connected to the aforementioned output bus and an output terminal for removing data indicating a distorted selected waveform; a differential D/A transformer which is equipped with an input terminal connected to the output terminal of the aforementioned latch and an output

terminal for a differential analog current proportional to a selected waveform; and a driver which is equipped with a low-pass filter.

[0003]

In the case of the aforementioned device, because a passive filter was eliminated, a higher level of integration could be attained to reduce costs. However, not only did it require a large silicon area, but it also consumed a large amount of power. Moreover, because only the basic bit rate clock could be utilized, there was the problem that a circuit for generating a high over-sampling clock had to be added.

[0004]

Problem to be solved by the invention

In view of the aforementioned situation, the purpose of the present invention is to present a device for transmitting Manchester code data via an unshielded twisted-pair medium using waveform shaping circuits, and a method which can be implemented economically with low power consumption.

[0005]

Means to solve the problem

First, the present invention is characterized in that it is a waveform shaping circuit equipped with an input terminal, an output terminal, and multiple cascade circuit stages; the aforementioned cascade circuit stages are each configured with a delay circuit equipped with an input part and an output part, a current source, and a switching circuit; the aforementioned switching circuit is electrically connected to the output of the delay circuit and is controlled by the aforementioned delay circuit so as to connect a current source to the aforementioned output terminal; the delay circuit of the first cascade circuit stage is electrically connected to the aforementioned input terminal, and the other delay circuits are electrically connected to the outputs of the respective adjoining delay circuits preceding them in the aforementioned multiple cascade circuit stages; each of the aforementioned delay circuits has the same delay time; and each of the aforementioned current sources has a current value obtained from a finite impulse response time sample determined by the filter transfer function of the waveform shaping circuit.

[0006]

It is preferred that the filter transfer function of the aforementioned waveform shaping circuit have a raised-cosine impulse (raised-cosine impulse) response while the total delay time is ½ the bit time of the basic data rate or a multiple of that ½. Second, the present invention is

characterized in that the method used for waveform shaping involves a step in which a finite impulse response time sample is obtained based on a filter transfer function; a step in which multiple current sources, each equipped with a switching circuit, whose current values are in direct proportion to the time sample are provided; and a step in which, in multiple delay circuits each having the same delay time while the total of said delay times is ½ the bit time of Manchester code data, the Manchester code data are received by the input part of the first delay circuit, input parts of the other delay circuits are electrically connected to the output parts of adjoining delay circuits preceding them, and output parts of the respective delay circuits are electrically connected to the switching circuits which control [the path from] current sources to the respective output terminals.

[0007]

Third, the present invention is characterized in that in a device for transmitting Manchester code data via an unshielded twisted-pair medium which comprises a first, a second, a third, and a fourth waveform shaping circuits, the aforementioned waveform shaping circuits are each configured with an input terminal, an output terminal, and multiple cascade circuit stages; the aforementioned cascade circuit stages are each configured with a delay circuit equipped with an input and output, a current source, and a switching circuit; the aforementioned switching circuit is electrically connected to the output part of the delay circuit and is controlled by the aforementioned delay circuit so as to connect the current source to the output terminal; the delay circuit of the first cascade circuit is electrically connected to the input terminal, and the input parts of the other delay circuits are connected to the respective output parts of the delay circuits connected ahead of them in the aforementioned multiple cascade circuit stages; each of the aforementioned delay circuits has the same delay time while the total of said delay times is ½ the bit time of the Manchester code data, and each of the aforementioned current sources has a current value obtained from a finite impulse response time sample determined by the filter transfer function of the waveform shaping circuit.

[0008]

Furthermore, the device is configured such that the aforementioned first waveform shaping circuit receives the Manchester code data as its input, the aforementioned second waveform shaping circuit receives delayed Manchester code data as its input, the output terminal of the aforementioned second waveform shaping circuit is connected to the output terminal of the first waveform shaping circuit, the third waveform shaping circuit receives inverted Manchester code data as its input, the aforementioned fourth waveform shaping circuit receives delayed inverted Manchester code data as its input, and the output terminal of the

aforementioned third waveform shaping circuit and the output terminal of the aforementioned fourth waveform shaping circuit are connected to each other.

[0009]

These and other purposes, characteristics, and advantages of the present invention will be explained below, with reference to figures.

[0010]

Embodiment of the invention

First, in Figures 1 and 2, the waveform shaping circuit comprises an input terminal (IN) (not illustrated) for receiving input data, an output terminal (OUT), and multiple cascade stages 1. The aforementioned cascade stages 1 are each configured with delay circuit 10 equipped with an input and output, current source 11, and switching circuit 12. In the present application example, the input of each delay circuit 10 has first and second input parts (IP and IN). Moreover, its output has first and second output parts (OP and ON). Furthermore, in order to receive the input data, in the aforementioned multiple cascade circuit stages 1 delay circuit 10 of the first cascade circuit stage 1 is electrically connected to the buffer (B) of the input terminal (IN), and a positive signal and a negative signal output from the buffer (B) are respectively input to the first and second input parts (IP and IN) of the first cascade circuit stage 1. The input parts (IP and IN) of the other delay circuits are electrically connected to the output parts (OP and ON) of the delay circuits provided ahead of them, and the aforementioned respective delay circuits have the same delay time.

[0011]

Here, current source 11 of the aforementioned cascade circuit stage 1 is made of a MOS transistor and has a grounded source electrode and a gate electrode connected to a given current source reference voltage, and the value of the current is obtained from a finite impulse response time sample determined by the filter transfer function of the waveform shaping circuit. The aforementioned impulse response and the causal system must be symmetrical with respect to the time axis. In the present application example, the filter transfer function has a raised-cosine impulse response. Therefore, minimal inter-symbol (inter-symbol) interference usually occurs in the case of a long transmission medium. In addition, the total number of delay stages and the number of delays in a stage are determined based on the accuracy of the transfer function required.

[0012]

Furthermore, switching circuit 12 of each respective cascade circuit stages 1 is configured with first and second MOS transistors 121 and 122. Here, the gate electrodes of first and second MOS transistors 121 and 122 are electrically connected to the respective output parts (ON and OP) of the delay circuit 10 corresponding to cascade circuit stage 1 via an inverter (INV), the drain electrode of the second MOS transistor 122 of each switching circuit 12 is electrically connected to the output terminal (OUT) of the aforementioned waveform shaping circuit, and its source electrode is electrically connected to the drain electrode of the corresponding current source 11. Furthermore, the drain electrode of each first MOS transistor 121 is electrically connected to the gate electrode of the corresponding current source 11, and its source electrode is electrically connected to a bias circuit (BS) which supplies a current reference voltage (CSS). Thus, the respective switching circuits 12 are controlled by their corresponding delay circuits 10, while at the same time they are connected to current sources 11 to the output terminal (OUT).

[0013]

Next, Figure 3 is a block diagram of a device which is configured with first, second, third, and fourth waveform shaping circuits (C1, C2, C3, and C4) and used for transmitting Manchester code data via an unshielded twisted-pair medium (UTP). Delay circuits 10 of the aforementioned respective waveform shaping circuits (C1, C2, C3, and C4) have the same delay times while the total of said delay times is ½ the bit time of Manchester code data or a multiple of that ½. In the present application example, the buffer of first waveform shaping circuit C1 receives Manchester code data (HTD) as its input, the buffer of second waveform shaping circuit C1 [sic; C2] receives delayed Manchester code data (LTD) as its input, and the output terminal (OUT) of the aforementioned second waveform shaping circuit C2 and the output terminal (OUT) of the aforementioned waveform shaping circuit C1 are connected to each other. Furthermore, the aforementioned third waveform shaping circuit C3 receives inverted Manchester code data (LTD–) as its input, and the aforementioned fourth waveform shaping circuit C4 receives delayed inverted Manchester code data (HTD–) as its input; and the output terminal (OUT) of the aforementioned third waveform shaping circuit C3 and the output terminal (OUT) of the aforementioned fourth waveform shaping circuit C4 are connected to each other. Here, all waveform shaping circuits (C1, C2, C3, and C4) perform the same function. The aforementioned first and fourth waveform shaping circuits (C1 and C4) and the aforementioned second and third waveform shaping circuits (C2 and C3) are complementary to each other in that they generate differential output signals for driving discrete transformer (T). In addition, the bias levels (BIAS 1) of the aforementioned first and fourth waveform shaping circuits (C1 and C4)

differ from the bias levels (Bias 2) of the aforementioned second and third waveform shaping circuits (C2 and C3) in order to create a certain ratio between the current values of a non-delayed Manchester signal and a delayed Manchester signal. The ratio between the current values of the non-delayed Manchester signal and the delayed Manchester signal is usually set between 5:1 and 3:1 in order to produce a transmission distortion in order to reduce signal jitter at a remote receiving terminal. This is called a transmission equalization method.

[0014]

Furthermore, the output terminals (OUT) of the first and second waveform shaping circuits (C1 and C2) are electrically connected to a first low-pass filter (LPF1), and the output terminals (OUT) of the third and fourth waveform shaping circuits (C3 and C4) are electrically connected to a second low-pass filter (LPF2). Also, in the case of a discrete transformer (T) equipped with a primary coil and a secondary coil, the primary coil is connected to the first low-pass filter (LPF1) and the second low-pass filter (LPF2) at either end, CT (the center tap) of the aforementioned primary coil is connected to a positive power supply, and the output end of the aforementioned secondary coil is connected to an unshielded twisted-pair medium (UTP).

[0015]

It should be noted that the first transistors of the first and fourth waveform shaping circuits (C1 and C4) are biased using a first bias voltage (BIAS1), and the first transistors of the second and third waveform shaping circuits (C2 and C3) are biased using a second bias voltage (BIAS2). The level of precompensation is therefore set according to the first and the second bias voltages (BIAS1) and (BIAS2). Because the outputs of the first, second, third, and fourth waveform shaping circuits (C1, C2, C3, and C4) are dependent on the shapes of the current sources, the output voltages are generated by external load resistors (R1 and R2) serving as the source end points of signals reflected from the unshielded twisted-pair medium (UTP).

<u>Brief description of the figures</u>

Figure 1 is a block diagram showing the waveform shaping circuits of the present invention.

Figure 2 is a circuit diagram of the waveform shaping circuit of the present invention.

Figure 3 is a block diagram showing a device which utilizes the multiple waveform shaping circuits shown in Figure 1 in order to transmit Manchester code data via an unshielded twisted-pair medium.

Explanation of symbols

1 Cascade circuit stage

10 Delay circuit

11 Current source

12 Switching circuit

121 First MOS transistor

122 Second MOS transistor

C1-C4 Waveform shaping circuit

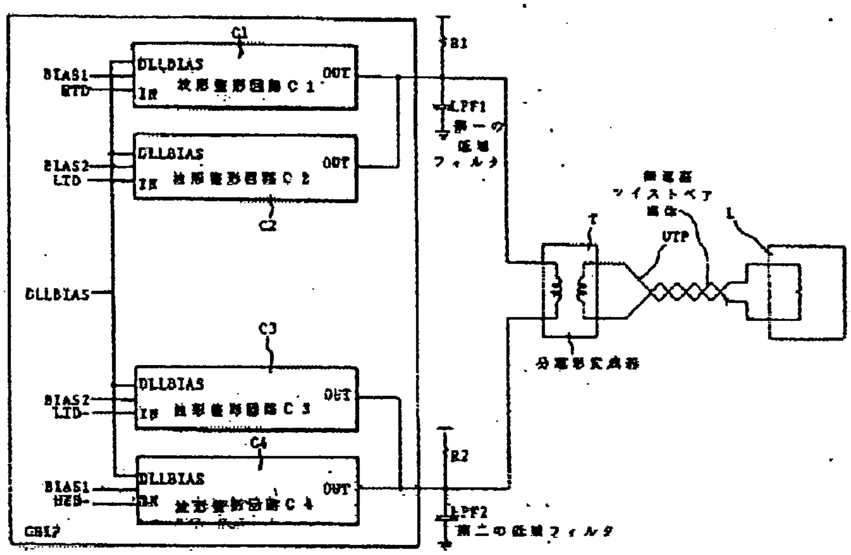


Figure 1

Key:	C1 through C4	Waveform shaping circuit
	LPF1	First low-pass filter
	LPF2	Second low-pass filter
	T	Discrete transformer
	UTP	Unshielded twisted pair medium

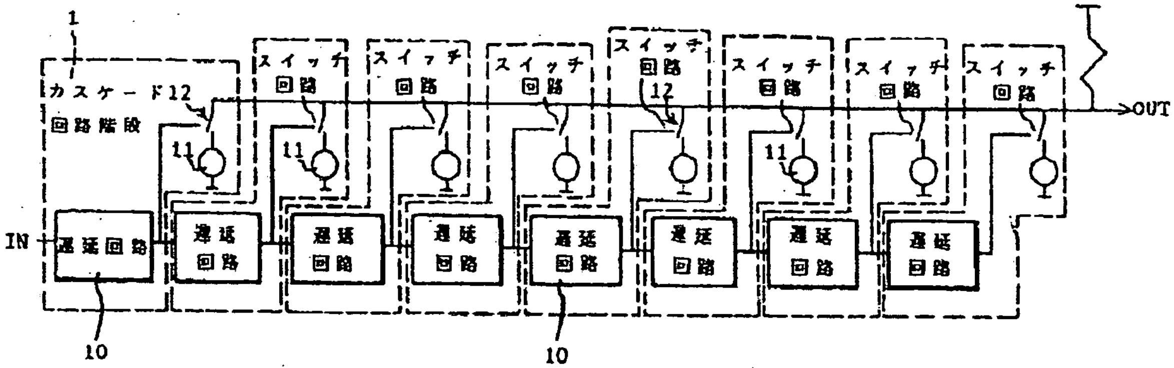


Figure 2

Key: 1 Cascade circuit stage
10 Delay circuit
12 Switching circuit

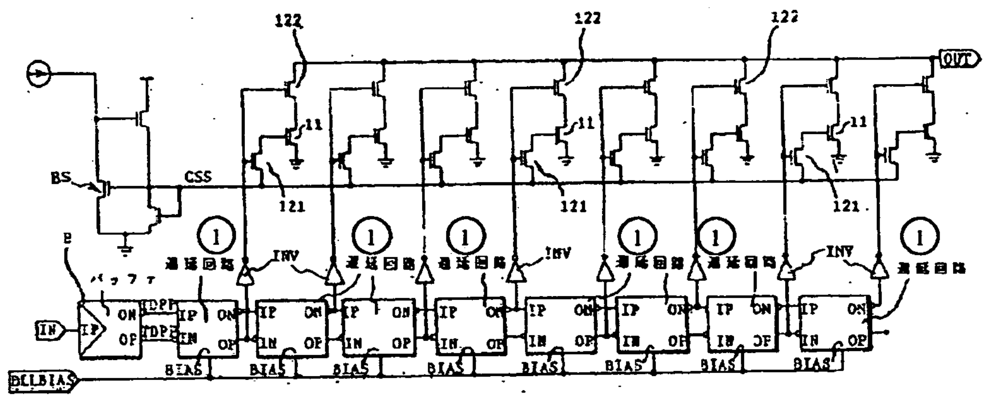


Figure 3

Key: B Buffer
1 Delay circuit

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Japanese Kokai Patent Application No. Hei 9[1997]-55770A

Job No.: 7073-102527 Ref.: JP09055770A
Translated from Japanese by the Ralph McElroy Translation Company
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